MULTI-AMP®
BIDDLE™
MEGGER®

Biddle Part# 12510
MS-2/ITA-1

Electrical Test Equipment
Measuring Instruments
Testing and
Training Services

AVO®™

AVO INTERNATIONAL

OVIA

AVO MULTI-AMP CORPORATION

INSTRUCTION MANUAL

For

HIGH CURRENT TEST SET

MODEL MS-2

And
OPTIONAL ACCESSORY MODEL ITA-1

SERIAL NO._____

It is essential that this instruction book be read thoroughly before putting the equipment in service.

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Part Nº 12510
Rev. 3

APPRECIATION

We are indebted to the manufacturers of circuit breakers and motor overload relays, who have given their time and advice in the preparation of this instruction book.

IMPORTANT

The information and data contained within this instruction manual are proprietary with AVO MULTI-AMP Corporation. The equipment described herein may be protected by one or more U.S. letters patent. AVO MULTI-AMP specifically reserves to itself all rights to such proprietary information as well as all rights under any such patent, none of which is waived by the submission of this instruction manual to anyone.

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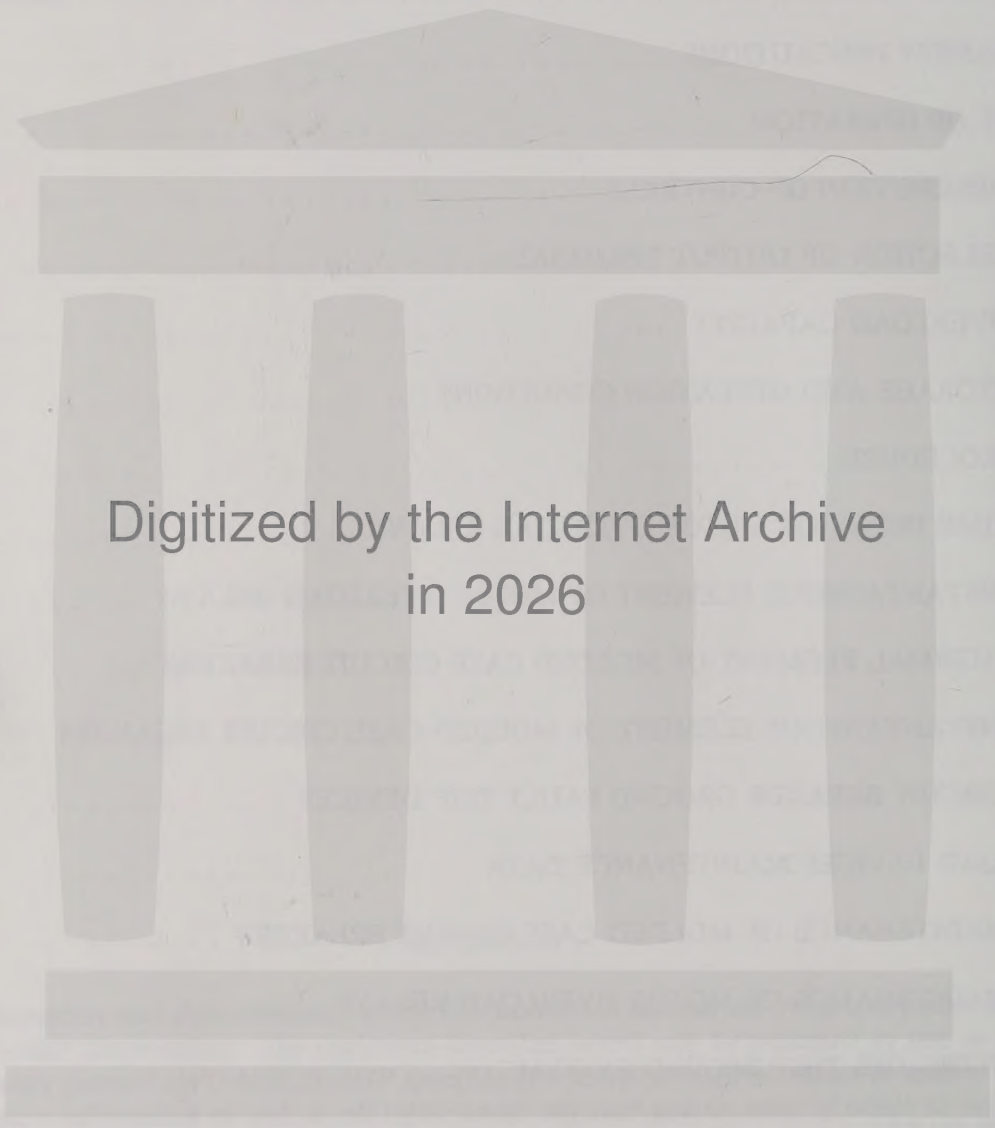

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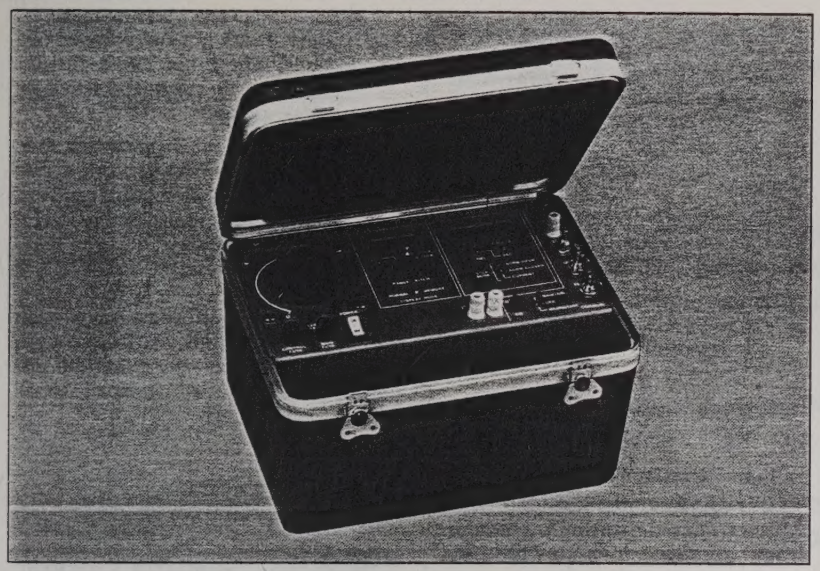

MULTI-AMP® Model MS-2

- **Digital memory ammeter**
- **Digital, multirange timer**
- **High-current output**
- **Solid-state output initiate circuit**
- **Portable, high-current test set**

Circuit Breaker and Overload Relay Test Set

DESCRIPTION

The Multi-Amp® Model MS-2 test set is used around the world by several thousand utility companies, industrial plants and electrical service organizations.

Using the latest technology, Model MS-2 is a self-contained test set that incorporates a variable high-current output and appropriate control circuitry and instrumentation for testing thermal, magnetic or solid-state motor overload relays; molded-case circuit breakers; and ground-fault trip devices.

APPLICATIONS

Model MS-2 is capable of testing the time-delay characteristics of motor overload relays and molded-case circuit breakers rated up to 125 amperes, when following the re-commended test procedure of testing the time delay of these devices at three times their rating.

Higher currents are available for the short durations required to test an instantaneous trip element. For example, the test set will provide a maximum short-duration output of 750 amperes through a typical, 125-ampere, molded-case circuit breaker.

Additional applications include ratioing current transformers and testing panelboard ammeters and voltmeters.

FEATURES AND BENEFITS

- Digital memory ammeter: High-accuracy, direct-reading instrument has read-and-hold memory for measurement of short-duration currents.
- Digital, multirange timer: Crystal-controlled, high-accuracy instrument with autoranging measures operating time to 1 millisecond.
- High-current output: Instrument will provide 750 amperes through a 125-ampere breaker.
- Rugged and lightweight: Unit weighs only 33 lb (15 kg) and is tough enough to withstand daily field or plant use.
- Solid-state output initiate circuit: Completely solid-state circuit eliminates need for contact maintenance.

SPECIFICATIONS

Input

Input Voltage (specify one)
120 V **OR** 240 V, 50/60 Hz, 1ϕ

Output

Output Ranges: The output is continuously adjustable in four ranges to accommodate a variety of test-circuit impedances:

0 to 5 A at 120 V max.
0 to 25 A at 24 V max.
0 to 120 A at 6 V max.
0 to 240 A at 3 V max.

Output Capacity: The output circuit is designed to permit short-duration overloads and the output ranges will provide several times their current rating, provided the output voltage is sufficient to push the desired current through the impedance of the test circuit.

The test set is capable of testing the time-delay characteristics of devices rated up to 125 amperes using a test current of three times their rating (375 amperes). Additionally, to perform an instantaneous trip test, it will provide 750 amperes through a typical, 125-ampere, molded-case circuit breaker connected with the test leads that are provided with the test set.

Overload Capability: To increase utilization of the test set, it is designed so that the current ratings may be exceeded for short durations. Because the magnitude of the output current is determined by the impedance of the load circuit, the voltage rating must be sufficient to push the desired current through the device under test and the connecting test leads.

Percent Rated Current	Maximum Time On	Minimum Time Off
100 (1x)	30 min	30 min
200 (2x)	3 min	8 min
300 (3x)	30 s	4 min
400 (4x)	7 s	2 min

Output Initiate Circuit: The test set uses a completely solid-state output initiating circuit. To increase reliability and eliminate contact maintenance, this circuit uses a triac instead of a contactor to initiate the output.

The initiating circuit provides momentary and maintained modes to control output duration. The momentary mode is used whenever the output is to be on for a short duration, such as when performing instantaneous trip tests, or to avoid damage or overheating of the device under test while setting the test current.

In the maintained mode, the output remains energized until manually turned off or, when performing timing tests, until the device under test operates—which both stops the timer and de-energizes the output.

Instrumentation

Ammeter

Operating Modes (switch-selected)
Memory
Normal

Display: 3½-digit, extra-bright LED display with 0.3-in. (8-mm) numerals

Ranges (switch-selected)
0 to 1.999/19.99/199.9/750 A

Accuracy (overall ammeter system)
±1% of reading, ±1 digit on three high ranges ±1% of range, ±1 digit on low range

Timer

Display: 5-digit, extra-bright, LED display with 0.3-in. (8-mm) numerals

Ranges (switch-selected)
0 to 99.999 s
0 to 999.99 s
0 to 99999 cycles

Accuracy: ±0.005% of reading, ±1 digit

Timer Control Circuit

This circuit automatically starts the timer when the output is energized and automatically stops the timer and de-energizes the output when the device under test operates. This circuit accommodates the following test conditions by simple switch selection of the appropriate mode:

Current Actuated: Used to test a device that has no auxiliary contacts to monitor, such as a single-pole circuit breaker. The timer stops when the output current is interrupted.

Normally Closed: Used to test a device with normally closed contacts. The timer stops and the output is de-energized when the contacts open.

Normally Open: Used to test a device with normally open contacts. The timer stops and the output is de-energized when the contacts close.

Enclosure

The test set is housed in a high-strength, molded, suitcase-type enclosure with carrying handle and removable cover. Storage space is provided for test leads.

Dimensions

9.9 H x 14 W x 11 D in.
25 H x 35 W x 28 D cm

Weight

33 lb (15 kg)

ORDERING INFORMATION

Item (Qty)	Cat. No.
Model MS-2	
115-volt input	MS-2-115
230-volt input	MS-2-230
Included Accessories	
Timer control circuit leads, 5 ft [1.5 m] (2)	1282
Test and maintenance record cards	
Green (50)	2239
Buff (50)	2238

Item (Qty)	Cat. No.
No. 4 high-current leads, 5 ft [1.5 m] (2)	2265
Fuses	
5 A, 250 V, MDA (5)	952
0.125 A, 250 V, MDL (5)	981
10 A, 250 V, MDA (5)	984
0.0625 A, 250 V, MDL (5)	987
Instruction manual (1)	8470

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SAFETY PRECAUTIONS

Every consideration has been given to the design and construction of the Multi-Amp Model MS-2 Portable High Current Test Set to make it a safe piece of test equipment as well as one that is accurate, reliable, and easy to use.

WARNING

The Model MS-2 is not designed for use on energized circuits. For the safety of the operator and protection of the instrument, do not connect it to circuits that are energized. This includes circuits that could become energized during the course of a test procedure utilizing this instrument.

It must be remembered that the test set is capable of producing voltage and current levels that can be deadly if personnel come in contact with them.

For safe operation, it is absolutely essential that the technician properly and effectively ground (earth) the test set. This is accomplished by connecting the input line cord to a properly grounded receptacle.

CAUTION

The input voltage of this instrument is not selectable. All the units are shipped from the factory set up for operation from either a nominal 115 volt or 230 volt source. If the unit is to be used on a voltage source different than the nameplate specifies, major changes in the test set are required. It is necessary for the technician to contact the factory to obtain the necessary parts and instructions before attempting to change the input voltage of the test set.

The MS-2 should be properly operated by qualified personnel who have familiarized themselves with the test set and thoroughly read the instruction manual provided with it.

If questions arise concerning the care, operation, maintenance or application of the test set, contact the Multi-Amp Corporation for assistance.

THEORY OF OPERATION

DESCRIPTION OF CONTROLS

This section of the instruction manual describes the functions of all the various control switches, etc. which are located on the control panel of the Model MS-2. All controls are clearly marked and logically grouped so that continual reference to the instruction manual should not be necessary after the operator has become acquainted with the operation of the test set. For the location of the controls described in this section, see MS-2 Control Panel Figure #1.

POWER ON/OFF Switch: Controls input power to the test set. The self-protected switch resets after an overload, when placed in the OFF position. Displays will light when the switch is ON.

MAIN FUSE: Protects power output circuit of MS-2 against overloads.

CONTROL FUSE: Protects instrumentation and control circuitry against overloads.

OUTPUT CONTROL: Variable autotransformer provides continuous non-stepped output from a variety of current-rated terminals. Output system is controlled by a combination of timer STOP MODE and output mode switch positions.

OUTPUT ON Lamp: Lights whenever output control circuit is energized.

OUTPUT Terminals: A combination of the COMMON terminal and any one of the four current-designated terminals provides an output circuit. Refer to other sections of the text for an explanation of the output characteristics of these terminals.

NOTE:

The current designation of these terminals has no bearing on the actual current output capability of each. Much higher currents can be achieved depending on test circuit impedance and duration of the test.

Output Mode Switch: Initiates the output circuit in conjunction with the appropriate Timer STOP MODE Switch position.

MOMENTARY Position:

Momentary 'ON' position with spring return to 'OFF'. Output will remain energized as long as switch is held in MOMENTARY position and is de-energized when released. Timer starts and stops in the same manner. Used for 'jogging' the output circuit.

MAINTAIN Position:

Maintained 'ON' position with spring return to 'OFF'. Output will remain energized until appropriate STOP MODE function occurs, switch is moved to 'OFF' position or current drops below threshold requirement.

OFF Position:

Test set input power remains energized but output current remains de-energized and timer will not count.

AMMETER: LED displays show the numeral one in the left most position when the meter is over-ranged.

RANGE SWITCH: Decimal of display shifts one digit to the right for each increase in range selection.

DISPLAY MODE Switch: Selects either the NORMAL or MEMORY mode of the ammeter.

NORMAL Position:

Ammeter updates reading continually as long as the output is energized. Reading is lost when the output is de-energized.

MEMORY Position:

Ammeter retains the highest peak value attained during current output operation above 8% of the full scale of range selected. Reading is retained until the output is re-initiated or RANGE SWITCH position is changed.

TIMER: Automatically resets each time output is re-initiated.

CYCLES/SEC. Switch: Selects cycles or seconds mode.

CYCLES Position:

The timer counts in whole cycles and uses the power input line frequency as timing reference.

SEC. Position:

The timer counts in two selectable increments and uses an internal 10kHz oscillator as timing reference.

.01/.001 Switch: Selects one of two counting increments available for the timer SEC. mode.

Note: Changing the position of the CYCLE/SEC. Switch (or the .01/.001 Switch while in the SEC. position) during timer operation will produce erroneous readings.

CONTACTS Binding Posts: Circuit controls output and timer in the normally open or normally closed positions of the STOP MODE Switch.

Note: Do not connect CONTACTS binding posts to an energized circuit.

STOP MODE Switch: Selects either current actuated position to stop the current output and timer, or either of the two external contact stop mode positions.

NORM. OPEN Position:
With CONTACTS binding posts connected to normally open contacts, output circuit will remain energized and timer will continue to run until contacts close.

NORM. CLOSED Position:
With CONTACTS binding posts connected to normally closed external contacts, output circuit will remain energized and timer will continue to run until contacts open.

CURRENT Position:
Timer will initiate only when the output circuit is completed and a threshold current of approximately 8% of full scale of ammeter range selected is exceeded. Timer will continue to run until output circuit opens, current drops below threshold level or output is de-energized.

SELECTION OF OUTPUT TERMINAL

Four output terminals at various voltage and current ratings are provided to adapt the MS-2 to a wide variety of test circuit impedances.

The current ratings shown on the output taps are the continuous duty ratings. The test set works at peak efficiency when the outputs are used at two to three times their continuous rating. In this way, finer adjustment can be obtained by making full use of the variable autotransformer range. The LOW CURRENT-HIGH VOLTAGE terminals should be used when testing high impedance devices where the lower voltage terminal(s) will not "push" the desired test current through the device. For example, to test a breaker rated at 15 amperes, at a test multiple of 3x (45 amperes), the operator should use the 25A output tap (not the 120A tap).

IT SHOULD BE NOTED THAT THERE IS NO RELATIONSHIP BETWEEN THE AMMETER RANGES AND THE RATING OF THE OUTPUT TERMINAL. All ammeter ranges can be used in conjunction with any of the output terminals.

MS-2 Control Panel
Figure 1

Part № 12510
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OVERLOAD CAPACITY

Model MS-2 is rated at 0.6 kVA output and is equipped with four output terminals, each capable of supplying its rated current. The current rating of these output terminals may be exceeded for short durations provided the voltage rating is sufficient to "push" the desired current through the device under test and the connecting test leads. The overload capacity, represented by multiples of rated current, versus TIME ON and TIME OFF are given below:

%Rated Current	Maximum Time ON	Minimum Time OFF
100 (1x)	30 minutes	30 minutes
150 (1.5x)	6 minutes	13 minutes
200 (2x)	3 minutes	8 minutes
250 (2.5x)	1 minute	6 minutes
300 (3x)	30 seconds	4 minutes
400 (4x)	7 seconds	2 minutes

Model MS-2 also can be used continuously for any reasonable length of time at 70.7% of the current rating of the output terminal.

EXAMPLE:

Consider the terminal rated at 240 amperes:

(a) 240 amperes may be drawn at any voltage from 0-2.5 volts for 30 minutes provided the test set is subsequently de-energized for 30 minutes.

(b) 169.7 amperes (70.7% of 240 amperes) may be continuously drawn at any voltage from 0-2.5 volts for any reasonable length of time.

(c) The following overload currents may be drawn at any voltage from zero to maximum volts for the Time ON indicated, followed by the indicated Time OFF. The maximum output voltage available when the current rating of the output terminal is exceeded (overloaded) will be less than the rated value due to the regulation of the transformer in the test set. For example, when drawing 360 amperes from the 240 ampere terminal, the maximum voltage available is approximately 2.0 volts.

Overload Current From 240 Ampere Terminal	Time ON	Time OFF
360 amperes	6 minutes	13 minutes
480 amperes	3 minutes	8 minutes

It should be noted that because of the impedance of the device under test and the connecting test leads, the maximum practical test current available from the terminal rated 240 amperes is approximately 360 amperes. Higher currents are usually available from the terminal rated 120 amperes; HOWEVER, these higher currents are available only for very short durations as illustrated in the overload capacity table above. For example, it is possible to get 480 amperes from this terminal for seven (7) seconds, followed by two (2) minutes off.

STORAGE AND OPERATION CONDITIONS

The unit is housed in an industrial grade plastic enclosure. There are no special storage requirements in the area of ventilation, or preservation with the lid securely attached to the unit. The unit is designed to be operational at temperatures between 0°C to 50°C and relative humidity between 0% and 90% non-condensing. The unit can be stored at temperatures between -25°C to 70°C and relative humidity between 0% and 90% non-condensing.

TEST PROCEDURE FOR
TIME DELAY OF MOTOR OVERLOAD RELAYS

1. Set-up MS-2 with:
   a. POWER ON/OFF Switch in OFF position (instrument displays off).
   b. OUTPUT CONTROL knob at minimum '0' position.
   c. Output Mode Switch in center OFF position.

2. Connect one end of a high-current lead to one side of thermal element or current coil in overload relay. Connect other end of this lead to the COMMON terminal of test set.

3. Connect one end of second high-current lead to other side of thermal element or current coil in overload relay. Connect other end of this lead to the appropriate output terminal (see SELECTION OF OUTPUT TERMINAL, page 4).

4. Connect test set to suitable single-phase power supply.

5. Turn test set on with POWER ON/OFF Switch (instrument displays should light).

6. Use RANGE Switch to select ammeter range so test current will be near full scale and no less than 10% of full scale.

7. Put ammeter DISPLAY MODE Switch in MEMORY position.

8. Connect a pair of light leads (timer leads) from Normally Closed Contacts or Normally Open Contacts of overload relay to binding posts of test set labeled CONTACTS.

9. Select appropriate timer STOP MODE.

10. Select desired timer display mode and range.

11. Rotate OUTPUT CONTROL knob clockwise and momentarily press Output Mode Switch in MOMENTARY and release. Observe current reading retained by ammeter.

12. Continue to rotate OUTPUT CONTROL knob clockwise while jogging (repeatedly moving to MOMENTARY position and releasing) Output Mode Switch until desired test current is reached. Suggested test current is three times (3x) the rating of thermal relays or three times (3x) the pick-up current of magnetic relays.

    If the relay utilizes a high impedance thermal element or operating coil and the desired test current cannot be reached, transfer output lead to the next higher voltage (lower current) terminal, and repeat Steps 11 and 12. If test current is still not reached, transfer output lead to terminal labeled 5A, and repeat Steps 11 and 12 (see SELECTION OF OUTPUT TERMINAL, page 4).

    NOTE: Before starting test, allow time for thermal element to cool; or in the case of magnetic overload relays, for the piston to reset. Incorrect tripping time may otherwise result.

13. Put ammeter DISPLAY MODE in NORMAL position.

14. Start test by moving Output Mode Switch to MAINTAIN position.

NOTE: Test current may decrease (fall off) during the test because the resistance or impedance of the test circuit increases as it heats up. Rotate OUTPUT CONTROL knob clockwise to keep test current at desired value.

15. When overload relay trips, timer stops and output is de-energized. Timer indicates total elapsed time of the test in seconds or cycles.

16. Turn test set OFF with POWER ON/OFF Switch.

17. Record test results on Test Record Card.

IMPORTANT NOTE

In order to obtain accurate tripping times with some types of magnetic overload relays, particularly those using high viscosity oil, it may be necessary to "preheat" the relay by running rated current through the relay for a few minutes.

TEST PROCEDURE FOR
INSTANTANEOUS ELEMENT OF MOTOR OVERLOAD RELAYS

1. Set-up MS-2 with:
   a. POWER ON/OFF Switch in OFF position.
   b. OUTPUT CONTROL knob at minimum, '0' position.
   c. Output Mode Switch in center OFF position.

2. Connect one end of a high-current lead to one side of instantaneous element in overload relay. Connect other end of this lead to the COMMON terminal of test set.

3. Connect one end of second high-current lead to other side of instantaneous element in overload relay. Connect other end to the appropriate output terminal (see SELECTION OF OUTPUT TERMINAL, page 4).

4. Connect test set to suitable single-phase power supply.

5. Turn test set on with POWER ON/OFF Switch (instrument displays should light).

6. Use RANGE Switch to select ammeter range so test current will be near full scale and no less than 10% of full scale.

7. Put ammeter DISPLAY MODE in MEMORY position.

8. Connect a pair of light leads (timer leads) from Normally Closed Contacts or Normally Open Contacts of overload relay to binding posts of test set labeled CONTACTS.

9. Select appropriate timer STOP MODE.

10. Select desired timer display mode and range.

11. Rotate OUTPUT CONTROL knob clockwise and momentarily press Output Mode Switch in MOMENTARY and release. Observe current reading retained by ammeter.

    If desired, test current is not reached with OUTPUT CONTROL knob at maximum clockwise rotation, return knob to zero and transfer output lead to the next higher voltage/lower current tap. For example, from terminal labeled 240A to terminal labeled 120A. Proceed with current adjustment as in Step 11.

    If the relay utilizes a high impedance instantaneous element and the desired test current cannot be reached, transfer output lead to the next higher voltage, lower current terminal, and repeat Step 11. If test current is still not reached, transfer output lead to terminal labeled 5A, and repeat Step 11 (see SELECTION OF OUTPUT TERMINAL, page 4).

12. Continue Step 11 until overload relay trips. Observe current reading retained on ammeter. Timer indicates elapsed time of test in cycles or seconds.

NOTE: To avoid tripping error caused by interference of time delay element, allow thermal element to cool; or in the case of magnetic overload relays, for the piston to reset.

13. Repeat test, starting with OUTPUT CONTROL knob at position just below trip current of instantaneous element observed in Step 12.

14. When overload relay trips, timer stops and output is de-energized. Current reading is retained on ammeter. Timer indicates elapsed time in seconds or cycles.

15. Turn test set OFF with POWER ON/OFF Switch.

16. Record results on Test Record Card.

IMPORTANT NOTE

Refer to manufacturer's instructions for instantaneous trip time. If increasing test current does not decrease tripping time, current at which minimum tripping time was first observed is the instantaneous trip current value. Additionally, the test method outlined above is sometimes referred to as the "jogging" or "step" method. For nearly all applications, this method works best; however, there is another method referred to as the "run-up" method. Instead of the Output Mode Switch being in the MOMENTARY position, it is placed in the MAINTAIN position and the ammeter is placed in the NORMAL position. When the output is initiated, rotate OUTPUT CONTROL knob clockwise and observe current reading on ammeter. When the device trips, record trip current. If this method is used, it should be noted that the device is being heated with continuous current, and it is hard on the variable autotransformer windings and brush(es) (can cause premature wear-down of the brush(es) and carbon buildup - see Servicing on page 18).

TEST PROCEDURE FOR
THERMAL ELEMENT OF MOLDED CASE CIRCUIT BREAKERS

1. Set-up MS-2 with:
   a. POWER ON/OFF Switch in OFF position (instrument displays OFF).
   b. OUTPUT CONTROL knob at minimum, '0' position.
   c. Output Mode Switch in center OFF position.

2. Connect one end of a high-current lead to one pole of circuit breaker. Connect the other end of this lead to the COMMON terminal of test set.

3. Connect one end of the second high-current lead to the other side of the same pole of the circuit breaker. Connect other end of this lead to the appropriate output terminal (see SELECTION OF OUTPUT TERMINAL, page 4).

4. Connect test set to suitable single-phase power supply.

5. Turn test set on with POWER ON/OFF Switch (instrument displays should light).

6. Use RANGE Switch to select ammeter range so test current will be near full scale and no less than 10% of full scale.

7. Put ammeter DISPLAY MODE Switch in MEMORY position.

8. Place timer STOP MODE Switch in CURRENT position.

9. Select desired timer display mode and range.

10. Rotate OUTPUT CONTROL knob clockwise and momentarily press Output Mode Switch in MOMENTARY and release. Observe current reading retained by ammeter.

11. Continue to rotate OUTPUT CONTROL knob clockwise while jogging (repeatedly moving to MOMENTARY position and releasing) Output Mode Switch until desired test current is reached. Suggested test current is three times (3x) the rating of the circuit breaker.

    If desired test current is not reached with OUTPUT CONTROL knob at maximum clockwise rotation, return knob to zero and transfer output lead to the next higher voltage/lower current terminal. For example, from terminal labeled 240A to terminal labeled 120A. Proceed with current adjustment as in Steps 10 and 11 (see SELECTION OF OUTPUT TERMINAL, page 4).

    NOTE: Before starting test, allow time for the thermal element to cool, otherwise incorrect tripping time may result.

12. Put ammeter DISPLAY MODE in NORMAL position.

13. Start test by moving Output Mode Switch to MAINTAIN position.

NOTE: Test current may decrease (fall off) during the test because the resistance or impedance of the test circuit increases as it heats up. Rotate OUTPUT CONTROL knob clockwise to keep test current at desired value.

14. When circuit breaker trips, timer stops and output is de-energized. Timer indicates total elapsed time of the test in seconds or cycles.

15. Turn test set OFF with POWER ON/OFF Switch.

16. Record test results on Test Record Card.

IMPORTANT NOTE

Some types of circuit breakers are intended to trip only under high current fault condition, usually ten times (10x) rated current. They have only instantaneous characteristics and therefore will not trip using usual procedure described above. Refer to TEST PROCEDURES FOR INSTANTANEOUS ELEMENT OF MOLDED CASE CIRCUIT BREAKERS, page 12.

TEST PROCEDURE FOR
INSTANTANEOUS ELEMENT OF MOLDED CASE CIRCUIT BREAKERS

1. Set-up MS-2 with:

   a. POWER ON/OFF Switch in OFF position. (instrument displays OFF)
   b. OUTPUT CONTROL knob at minimum, '0' position.
   c. Output Mode Switch in center OFF position.

2. Connect one end of high-current lead to one pole circuit breaker. Connect the other end of this lead to the COMMON terminal of test set.

3. Connect one end of second high-current lead to the other side of the same pole of the circuit breaker. Connect other end of this lead to the appropriate output terminal (see SELECTION OF OUTPUT TERMINAL, page 4).

4. Connect test set to suitable single-phase power supply.

5. Turn test set on with POWER ON/OFF Switch (instrument displays should light).

6. Use RANGE Switch to select ammeter range so test current will be near full scale and no less than 10% of full scale.

7. Put ammeter DISPLAY MODE Switch in MEMORY position.

8. Place timer STOP MODE Switch in CURRENT position.

9. Select desired timer display mode and range.

10. Rotate OUTPUT CONTROL knob clockwise and momentarily press Output Mode Switch in MOMENTARY release. Observe current reading retained by ammeter.

    If desired test current is not reached with OUTPUT CONTROL knob at maximum clockwise rotation, return knob to zero and transfer output lead to the next higher voltage/lower current terminal. For example, from terminal labeled 240A to terminal labeled 120A. Proceed with current adjustment as in Step 10 (see SELECTION OF OUTPUT TERMINAL, page 4).

11. Continue Step 10 until circuit breaker trips. Observe current reading retained by ammeter. Timer indicates elapsed time of test in seconds or cycles.

    NOTE: To avoid tripping error caused by time delay element over heating, allow time for it to cool.

12. Repeat test, starting with OUTPUT CONTROL knob at position just below trip current of instantaneous element observed in Step 11.

13. When circuit breaker trips, timer stops and output is de-energized. Current reading is retained on ammeter. Timer indicates elapsed time in seconds or cycles.

14. Turn test set OFF with POWER ON/OFF Switch.

15. Record results on Test Record Card.

IMPORTANT NOTE

Refer to manufacturer's instructions for instantaneous trip time. If increasing test current does not decrease tripping time, current at which minimum tripping time was first observed is the instantaneous trip current value. Additionally, the test method outlined above is sometimes referred to as the "jogging" or "step" method. For nearly all applications, this method works best; however, there is another method referred to as the "run-up" method. Instead of the Output Mode Switch being in the MOMENTARY position, it is placed in the MAINTAIN position and the ammeter is placed in the NORMAL position. When the output is initiated, rotate OUTPUT CONTROL knob clockwise and observe current reading on ammeter. When the device trips, record trip current. If this method is used, it should be noted that the device is being heated with continuous current, and it is hard on the variable autotransformer windings and brush(es) (can cause premature wear-down of the brush(es) and carbon buildup - see Servicing on page 18).

TEST PROCEDURE FOR
CIRCUIT BREAKER GROUND FAULT TRIP DEVICES

1. Set-up MS-2 with:
   a. POWER ON/OFF Switch in OFF position. (instrument displays OFF)
   b. OUTPUT CONTROL knob at minimum, '0' position.
   c. Output Mode Switch in center OFF position.

2. Connect one end of a high-current lead to one pole of ground fault circuit breaker. Connect other end of this lead to the COMMON terminal of test set.

3. Connect one end of second high-current lead to the other side of the same pole of the ground fault circuit breaker. Connect the other end of this lead to the appropriate output terminal (see SELECTION OF OUTPUT TERMINAL, page 4).

4. Connect test set to suitable single-phase power supply.

5. Turn test set on with POWER ON/OFF Switch (instrument displays should light).

6. Use RANGE Switch to select ammeter range so test current will be near full scale and no less than 10% of full scale.

7. Put ammeter DISPLAY MODE in MEMORY position.

8. Place timer STOP MODE Switch in CURRENT position.

9. Select desired timer display mode and range.

10. Rotate OUTPUT CONTROL knob clockwise and momentarily press Output Mode Switch in MOMENTARY and release. Observe current reading retained on ammeter.

11. Continue to rotate OUTPUT CONTROL knob clockwise while jogging (repeatedly moving to MOMENTARY position and releasing) Output Mode Switch until desired test current is reached. Suggested test current is one and one half times (1.5 x) the rating of the ground fault trip device.

    If desired, test current is not reached with OUTPUT CONTROL knob at maximum clockwise rotation, return knob to zero and transfer output lead to the next higher voltage/lesser current terminal. For example, from terminal labeled 240A to terminal labeled 120A. Proceed with current adjustment as in Steps 10 and 11 (see SELECTION OF OUTPUT TERMINAL, page 4).

12. Put ammeter DISPLAY MODE in NORMAL position.

13. Start test by moving Output Mode to MAINTAIN position.

14. When device trips, timer stops and output is de-energized. Timer indicates total elapsed time of the test in seconds or cycles.

15. Turn test set OFF with POWER ON/OFF Switch.

16. Record test results on Test Record Card.

IMPORTANT NOTE

Refer to manufacturer's instructions for proper test current value and tripping time.

OVERLOAD DEVICES MAINTENANCE DATA

MAINTENANCE OF MOLDED CASE CIRCUIT BREAKERS

The molded case circuit breaker essentially consists of two separate elements. One element is a set of contacts and suitable mechanical linkage for manual operation of the breaker as a switch in an electrical circuit. The other element is a device that senses and reacts to an overload or short circuit. Normally, the time delay overload device is thermal and the instantaneous overload device, when supplied, is magnetic. The thermal element usually uses a bimetallic strip; two pieces of dissimilar material bonded together. An overload causes an increase in heat which will result in moving the bimetallic unit and eventually trip the circuit breaker. The magnetic element operates with no intentional time delay to provide instantaneous protection against high magnitude faults.

PLANNED MAINTENANCE PROGRAM

A scheduled program for maintenance of molded case circuit breakers consists primarily of "good housekeeping" in conjunction with visual inspections and electrical tests. A brief outline is given below:

1. Clean

   All types of molded case circuit breakers should be externally cleaned so that the heat produced in normal operation can be dissipated properly. It is possible for dirt or dust caused by normal plant conditions to accumulate and prevent proper dissipation of heat, resulting in a nuisance operation of the breaker.

2. Tighten Connections

   This is particularly important because loose electrical connections can cause extra heat which may result in an unnecessary operation of the breaker.

3. Test

   The molded case circuit breaker should be subjected to a simulated overload and the tripping time measured. This is important because after a period of inactivity, the overload device may become stiff or inoperable. The only way to determine this condition and eliminate the stiffness is to electrically operate the breaker on a periodic basis. Manually opening and closing the main contacts of the breaker does not move any of the mechanical linkage associated with the overload device. Testing may be as often as every 6 months or as long as every three or four years, depending upon conditions where the breaker is installed.

MAINTENANCE OF MOTOR OVERLOAD RELAYS

APPLICATION

The prime function of the motor overload relay is to prevent operation of a motor for too long a period of time when an overload condition exists.

In general, motor starters are applicable to a given horsepower range of motors. The voltage and current requirements of the application will "size" the starter under NEMA requirements, but the actual starting current, running current and ambient temperature will determine the overload relay rating required to protect the motor without nuisance tripping.

Selection of the properly rated overload relay can be made by reference to tables or charts supplied by the manufacturer of the overload relays and motors. Whenever a motor trips out, it is poor practice to uprate the overload relay indiscriminately; the motor may actually be working under an overload condition or the overload relay may be operating improperly. Uprating the overload relay could permit an overload to continue, resulting in deterioration of the motor insulation and reduction in motor life. Therefore, careful analysis should be made as to the cause of the nuisance trip before changing the rating of the overload relay.

Operating characteristics of the motor overload relay should be verified at regular intervals. Typical practice dictates inspection of overload relays at periods of one to two years, with an actual test of tripping time to be made at intervals of two years. The test interval can vary with the type of service involved and the importance of the motor to process or production.

TYPES

Motor overload relays incorporate an element which actuates a set of contacts connected to the motor control circuit. These contacts open the circuit of the holding coil in the motor starter and interrupt the power to the motor.

In general, there are three types of motor overload relays in use:

1. Thermal - melting alloy or solder pot
2. Thermal - bimetallic strip
3. Electromagnetic

In thermal type relays, time-current characteristics are obtained by the thermal properties of the melting alloy or bimetallic strip. In the magnetic type, a damped plunger or moving iron device is used to produce time delays.

1. Thermal - melting alloy or solder pot

   In this type, tripping is the result of heat generated by the motor load current passing through a "heater" in the overload relay. This overload relay consists of a brass shaft which is surrounded by solder. Fixed to one end of the shaft is a small ratchet wheel.

As long as the solder is solid, this assembly is immobile. When the motor control circuit contacts are closed, a spring is held compressed by the immobility of the ratchet wheel. An overloaded condition in the motor increases the current through the heater, thus melting the solder and releasing the energy in the spring. This interrupts the circuit of the holding coil in the motor starter and shuts down the motor.

The starter may be reset only after the temperature of the heater has cooled sufficiently to permit the solder to solidify and again make the ratchet and shaft immobile. Reset is usually accomplished by an external pushbutton on the face of the starter. Many heaters offer a selection of either manual or automatic reset.

2. Thermal - bimetallic strip

This type uses a bimetallic strip - two pieces of dissimilar metal bonded together. An increase in heat will cause movement of this bimetallic unit and eventually open a set of contacts in the motor control circuit, thus opening the holding coil circuit and shutting down the motor.

The principle of operation is the same as the melting alloy type. When the bimetallic element has cooled sufficiently, the motor control circuit may be reset either manually or automatically.

3. Electromagnetic

In this type of motor overload relay, a damped plunger or moving iron device is used to produce the delays required and initiate the trip signal to the interrupting device. The most common type of magnetic overload relay utilizes a plunger or iron core piston which extends from an oil filled dashpot into the operating coil of the relay.

When the electromagnetic field produced by the operating coil is strong enough, the piston moves through the oil and opens the contacts of the relay. A time-delay is achieved by the oil in the dashpot, retarding the movement of the piston. Usually magnetic overload relays with oil dashpots have facilities which permit adjusting their minimum operating current (pick-up point) and their time delay characteristics.

PLANNED MAINTENANCE PROGRAM

A scheduled program for maintenance of motor overload relays consists primarily of "good housekeeping" in conjunction with visual inspections and electrical tests. A brief outline is given below:

1. Clean

All types of motor overload relays should be cleaned periodically to ensure continued, reliable operation. It is possible for dirt or dust, created by conditions in the plant, to prevent parts of the relay from moving. These same conditions can also prevent the proper dissipation of normal heating, resulting in unnecessary operation of thermal type overload relays.

2. Tighten Connections

This is particularly important in thermal overload relays. Loose electrical connections can cause extra heat which may result in a nuisance operation of the relay.

3. Inspect Heater Size

Determine that the specified heater is used in thermal overload relays. Too often, oversized heaters are arbitrarily installed to eliminate unexplained trips. Actually, the original heaters may have oxidized after a period of time and become smaller in cross section. In that event, the heat required to operate the relay is provided by a smaller amount of current than that intended by the original design. This may make the relay trip prematurely and the heater appear undersized.

4. Inspect Settings (Where applicable)

Most magnetic overload relays have adjustable settings for minimum operating current and time delay characteristics. These should be adjusted to the specified settings.

5. Test

The motor overload relay should be subjected to a simulated overload and the tripping time measured. This should be compared to the manufacturer's specifications or the relay's time curves to make certain that the relay is operating properly. A tolerance of $\pm$ 15% is usually acceptable. If the relay's curves or specifications are not available, it is suggested that the Heat Damage Curve of the motor be used as a guide for maximum trip time at 300% of motor full load current.

USING THE TEST RECORD SYSTEM

Supplied with Model MS-2, these record cards enable the operator to maintain a complete, accurate history of periodic electrical tests (buff colored card) and mechanical inspections (green colored card) of both motor overload relays and molded case circuit breakers.

Additional cards are available from MULTI-AMP:
Electrical test record cards (buff) Part No. 2239
Mechanical inspection record cards (green) Part No. 2238

SERVICE DATA

SERVICING

The test set utilizes straightforward circuits and components which require little or no service except for routine cleaning, tightening of connections, etc. No special tools are required to perform the routine maintenance, only typical hand tools are required. The test set should be serviced in a clean atmosphere away from energized electrical circuits. The following maintenance is recommended:

Maintenance intervals depend on usage, but a maximum of every six months is recommended.

WARNING: Do not service unit unless it is disconnected from its power source.

1. Enclosure:

   The enclosure can be cleaned with a soft cloth. If heavily soiled, the cloth can be dampened with an approved solvent that does not attack the finish or leave residue.

2. Control Panel:

   The control panel can be wiped clean with a soft, dry cloth. Do not wipe the meter lenses with a cloth. If a breath of air will not remove dirt, brush it away lightly with a soft bristle instrument brush.

3. Variable Autotransformer:

   The brushes are designed for long life, but should be checked periodically for excessive wear or chipping. The brushes must be changed before the brass brush holder touches the contact surface or serious damage will result. The brush contact area of the winding should be inspected for burning, pitting, dirt or debris. If necessary, burnish surface with burnishing tool, remove filings and clean surface with a swab moistened with alcohol (100% solution).

4. Other Components:

   Check all knobs, printed circuit boards, screws, fasteners, connections and terminals for tightness and proper position. Remove dust with a soft brush and breath of air. Output terminal connection tightness is particularly important. If they become loose, excessive heating of the terminals and poor current output will result.

5. Insulation:

   Check wiring and other insulated components for burning, cracking or other damage.

IMPORTANT NOTE

Do not use lubricants or solvents of any kind in the test set except as specifically recommended.

SERVICE AND REPAIR ORDER INSTRUCTIONS

If factory service is required or desired, contact the factory for return instructions.

A Repair Authorization (RA) number will be assigned for proper handling of the unit when it arrives at the factory.

If desired, a letter with the RA number and instructions can be provided.

Provide the factory with model number, serial number, nature of the problem or service desired, return address, your name, and where you can be reached should the factory need to contact you.

A purchase order number, cost limit, billing, and return shipping instructions may also be provided if desired.

National Institute of Standards and Technology (NIST) traceable calibration and certification of two types is available, if desired, at additional cost:

Class One:

A certificate is provided verifying the traceability and calibration of the equipment.

Class N:

That which is required for nuclear power plants. A certificate of traceability and calibration along with "as found" and "as left" data are provided.

If an estimate is requested, provide the name and contact information of the person with approval/disapproval authority.

Pack the equipment appropriately to prevent damage during shipment. If a reusable crate or container is used, the unit will be returned in it if the container is in suitable condition.

Put the RA number on the address label of the shipping container for proper identification and faster handling at the factory.

NOTE: Ship the equipment without instruction manuals or nonessential items such as test leads, spare fuses, etc. These items are not needed to conduct repairs.

PREPARATION FOR RESHIPMENT

Save the shipping container for future use. The shipping container your unit came in is designed to withstand the normal bumps and shocks of shipping via common commercial carrier. For example, you may wish to reship your unit to Multi-Amp for annual calibration certification.

WARRANTY STATEMENT

Multi-Amp Corporation warrants to the original purchaser that the product is free of defects in material and workmanship for a period of one (1) year from date of shipment. This warranty is limited and shall not apply to equipment which has damage, or cause of defect, due to accident, negligence, improper operation, faulty installation by the purchaser, or improper service or repair by any person, company or corporation not authorized by Multi-Amp Corporation.

Multi-Amp Corporation will, at its option, either repair or replace those parts and/or materials that it deems to be defective. Any costs incurred by the purchaser for the repair or replacement of such parts and/or materials shall be the sole responsibility of the original purchaser.

THE ABOVE WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED ON THE PART OF THE MULTI-AMP CORPORATION, AND IN NO EVENT SHALL THE MULTI-AMP CORPORATION BE LIABLE FOR THE CONSEQUENTIAL DAMAGES DUE TO THE BREACH THEREOF.

OPERATIONAL ERRORS/TROUBLESHOOTING

Some operational errors will cause the operator to suspect a test set malfunction. Some examples of these with common causes are as follows. Some basic component failures and malfunctions are also identified.

1. Difference in Memory/Normal ammeter readings:
   Remember that the memory mode is for taking instantaneous peak readings and not for retaining continuous readings after the unit de-initiates. If used for continuous readings, an error will result. The Normal mode is calibrated to read RMS current. Do not switch from Normal to Memory to retain a reading or you will get a peak reading instead. The Memory and Normal readings will be nearly equal under normal conditions if the output current is maintained for several seconds after the meter is switched to the Memory position. The test set may need to be calibrated if the difference is very great.

2. No output current reading on the ammeter but the Output On lamp is lighted:

   a. Current output test circuit is open.
   b. Fuse F2 has failed.
   c. CT is open or CT circuit connector has come loose at PCB.

3. Power on, no instruments lighted:

   a. Power ON/OFF Switch (CB1) has failed.
   b. Fuse F1 has failed.
   c. Power supply assembly or RF1 filter has failed.

4. Power on, instruments lighted, unit will not initiate:

   a. Improper timer stop mode selection for desired test.
   b. Output test circuit open.
   c. Output Mode Switch assembly (Maintain/OFF/Momentary) is faulty or its connector has come loose from the PCB.
   d. Triac failure.

5. Same as above, will not initiate in N.O. or N.C. Contacts mode:

   a. Faulty test leads.
   b. Incorrect test scheme for stop mode selected.
   c. Contacts being monitored are in incorrect position for stop mode selected.
   d. Contacts monitoring circuit has failed. Commonly caused by connecting contacts binding posts to an energized circuit.
   e. Contacts binding post connector has come loose at PCB.

6. Upon completion of output circuit, current appears on ammeter, timer does not initiate:

   a. Initiate switch has been left in Maintain position after a test has been completed. The Output Mode Switch must always be returned to the off position when a test is completed or discontinued.

7. Power on, instrument displays lighted, either or both instruments will not function when unit is initiated:

   a. Failure in 15VDC power supply circuitry.
   b. Failure of protective diodes in current input or display section of ammeter.

   NOTE: Refer to other example conditions before assuming these failures.

PARTS LIST
Model MS-2 Portable High Current Test Set

Description	Part No.
System Schematic Drawing	20017C
Main Chassis Parts:	
Binding Post, red	156
Binding Post, Yellow	167
Binding Post, White	169
Line Cord, 3/C with Cap	2708
Knob, pointer	2130
Knob,	3860
Main Triac,25A 600V	4922
Line Filter, 1A	6344
Transformer, output	8375
Transformer, Current	8985
Transformer, variable auto	6029 (1)
Transformer, variable auto	3403 (2)
Circuit Breaker, 1P 10A 120V	8173 (1)
Circuit Breaker, 1P 5A 240V	8172 (2)
Resistor, 8k ohms	1431
Potentiometer, 200 ohm	6708
Output Control Switch Assembly	9067
Capacitor, .33MFD 600V	4304
Fuseholder	949
Lens Assembly, ammeter and timer	9574
Lampholder, cartridge type	8858
Lens, red indicator	8855
Lamp, cartridge type, 24V	8856 (1)
Lamp, cartridge type, 48V	8857 (2)
Power Supply Assembly, 120V input	8357 (2)
Power Supply Assembly, 240V input	8616 (2)
Control Logic PCB Assembly	9342
Enclosure with Lid	6630 (4)
Included Accessory Items:	
Accessory Leads, Timer	1282
Instruction Manual	8470
Fuse, 10A 250V MDA	984 (1)
Fuse, 5A 250V MDA	952 (2)
Fuse, .125A 250V MDL	981 (1)
Fuse, .0625A 250V MDL	987 (2)(3)

NOTES:
1. These parts apply to 120V input units.
2. These parts apply to 240V input units.
3. Not used on later models. Use P/N 981.
4. Top and bottom halves of enclosure not sold separately. Provide model number of test set when ordering the enclosure.

MODEL ITA-1 INSULATION RESISTANCE TEST ACCESSORY

GENERAL DESCRIPTION

See the Model MS-2 Portable High Current Test Set Bulletin, page 2.

SPECIFICATIONS

See the Model MS-2 Portable High Current Test Set Bulletin, page 2.

The following meter details are provided:

RANGES: At 500 volts DC:
2-100 megohms with LO-HI Switch in LO position
20-1000 megohms with LO-HI Switch in HI position

DESCRIPTION OF CONTROLS

This section of the instruction manual describes the functions of all the various control switches, etc., which are located on the control panel of the Model ITA-1. All controls are clearly marked and logically grouped so that continual reference to the instruction manual should not be necessary after the operator has become acquainted with the operation of the test set. The Model MS-2 instruction manual must be reviewed to properly understand the operating instructions of the ITA-1 and operate it correctly.

Input Power:	Provided by the MS-2.
Output Control:	Provided by the OUTPUT CONTROL knob of the MS-2.
LO-HI Switch:	Determines the range of resistance values read by the meter. In HI position, the resistance range of the meter is ten times greater than in the LO position.
SET-TEST Switch:	A spring loaded, center-off switch. When in the SET position, test voltage can be set to either 500VDC (half scale, as indicated by the red dot on the meter). In the TEST position, the SET voltage is applied to output jacks "L" and "E".
Neon Lamp:	Indicates when the ITA-1 is on. Glows only when the SET-TEST Switch is in either the set or test position and the voltage has been adjusted by means of the OUTPUT CONTROL knob of the MS-2.
"G" Guard Jack:	This is the black pin jack which is connected to the negative side of the ITA-1 output.
"E" Earth Jack:	This is the green pin jack which is connected to the positive side of the ITA-1 output.
"L" Line Jack:	This is the red pin jack which is connected to the metered, negative side of the ITA-1 output.

OPERATING INSTRUCTIONS

A. Set-up MS-2 with:

a. POWER ON/OFF Switch in OFF position (instrument displays off).
b. OUTPUT CONTROL knob at minimum, '0' position.
c. Output Mode Switch in center OFF position.

2. Connect green test lead from green "E" jack of the ITA-1 to ground (frame) side of the device in which insulation resistance is to be measured.

3. Connect red test lead to red "L" jack of the ITA-1 and leave probe in the vicinity of the "hot" side of the device being tested.

4. Connect MS-2 to suitable single-phase power supply.

5. Initiate MS-2 using POWER ON/OFF Switch (instrument displays should light).

6. Put timer STOP MODE Switch in NORM. OPEN position.

7. Put Output Mode Switch of MS-2 in MAINTAIN position.

8. Rotate MS-2 OUTPUT CONTROL knob clockwise and momentarily press and hold SET-TEST Switch of ITA-1 in SET position until desired test voltage is reached on the ITA-1 meter (500 volts at full scale or 250 volts at half scale, red dot). Release SET-TEST Switch.

9. Apply probe of red test lead to "hot" side of the equipment being tested.

10. Press and hold SET-TEST Switch in TEST position. Observe insulation resistance value reading on meter.

    If reading is in left hand (high value) portion of scale, put LO-HI Switch into the HI position and read insulation resistance value. Release SET-TEST Switch.

11. Record resistance value on the Test Record Card.

    NOTE: In some cases, it may be desirable to connect black "G" jack of the ITA-1 to the frame of the equipment being tested with the black test lead; e.g. when testing for insulation resistance of an open switch, between switch terminals.

INSULATION TESTING PROCEDURES

Following Operating Instructions, set-up ITA-1 for testing insulation of desired equipment or device. The voltage selected (250V or 500V) depends on the voltage rating of the insulation to be tested. Consult appropriate test standards for proper test voltage and acceptable insulation resistance value.

1. Disconnect the device from all sources of power.
2. Test circuit thoroughly to assure it is de-energized.
3. Connect the 'line' lead to the conductor to be tested.
4. Connect the 'ground' lead to the probable path to ground that the test voltage would take, should the insulation fail (e.g. motor frame, cable conduit, wire way, breaker frame).
5. For testing the insulation quality between two conductive components or devices (e.g. poles of a circuit breaker, coils of a motor), connect the "line" lead to one of the two conductive parts and the "ground" lead to the other.
6. For tests such as those in Step 5, connect the "guard" lead to the ground potential part of the device (breaker, frame, motor frame). For testing shielded cable, connect the "guard" lead to the shielding.
7. Perform the test at desired voltage and observe the insulation resistance on the meter.
8. The minimum test duration should be one minute. All tests should be performed for the same duration for consistency in resistance readings.
9. Release Test Switch at end of test or when a zero reading is observed.
10. Record results on Test Record Card.

If an immediate zero reading is observed, or occurs suddenly, stop the test. Check for possible unintentional grounding such as the 'Line' lead touching a ground path or the other end of a conductor under test touching ground, before assuming the insulation has failed.

If the meter registers infinity throughout the test, the circuit under test may be open. Check the circuit for continuity. Check the ITA-1 by connecting the ground and line leads together and momentarily push the test switch. The meter should deflect to zero. If most of the tests of similar circuits have been testing out at an infinite reading, the reading is probably correct.

A periodic check, as noted above, is a good practice to assure the ITA-1 is functioning properly and test leads are good.

Capacitors, resistors, diodes and other devices that block or absorb current flow should be removed from a circuit before insulation is tested or erroneous readings will result.

IMPORTANT NOTE

The ITA-1 should never be used to test continuity in a circuit. A false reading can result. The voltage output is high enough to cross breaks in wire, bad contacts, and in some cases, blown fuses. Continuity or circuit resistance should only be measured with an ohmmeter or continuity tester designed for the purpose. Contacts should be checked with a microhmmeter (ductor) or a highly sensitive multimeter.

FIELD INSTALLATION INSTRUCTIONS

The Model ITA-1 may be installed in the field by following these instructions.

A. Remove the MS-2 from its enclosure.

1. Make sure the line cord is disconnected from any power source.

2. Remove the enclosure cover and all the contents of the storage compartment.

3. Set the MS-2 on the side away from the storage compartment and remove the screw from the bottom of the enclosure.

4. Place your hand in the storage compartment, support the chassis and return the MS-2 to the upright position.

5. Remove the two large screws located at the edge of the control panel directly above the timer display and output control knob.

6. Tilt the chassis toward the storage compartment and grip the sides of the control panel. Lift the chassis from the enclosure.

B. Install the ITA-1.

1. Place the ITA-1 on the MS-2 so that the ITA-1 plug mates with the accessory socket on the MS-2, located on the lower left side of the MS-2 chassis wall. Make sure that the three captive 6-32 screws on the ITA-1 line up with the tapped inserts on the MS-2 chassis.

2. Push the ITA-1 plug part way into the accessory socket.

3. Tighten the three fastening screws gradually while exerting pressure on the ITA-1 chassis.

4. Tighten the three fastening screws securely.

C. Install the MS-2 chassis with the ITA-1 attached in the MS-2 enclosure.

1. Grasp the chassis by the sides of the control panel and set it inside the enclosure. Be sure the mounting blocks in the enclosure are on the side that will be adjacent to the top of the control panel.

   CAUTION: Make sure there are no wires pinched between the edges of the chassis at the sides or bottom of the enclosure.

2. Start the two mounting screws into the mounting blocks but do not tighten them.

3. Place your hand in the storage compartment and support the chassis while tilting the enclosure onto the side adjacent to the storage compartment.

4. With the chassis still supported with your hand, align mounting hole in the bottom of the chassis with the hole in the bottom of the enclosure.

5. Place the washer on the mounting screw and start the screw. Place a dab of waterproof sealing compound between the washer and enclosure surface.
6. Let the compound cure for a few minutes and tighten the screw.

7. Support the chassis as before and return the enclosure to the upright position. Tighten the other two mounting screws.

The Model MS-2 with the ITA-1 accessory is now ready for use.

MAINTENANCE PROCEDURES

Maintenance intervals depend on usage, but a periodic inspection of the ITA-1 should be performed. Frequent testing is recommended and a complete servicing performed a minimum of every six months.

NOTE: Unit must be removed from MS-2 enclosure to service it.

Enclosure and Control Panels

They can be cleaned with a soft cloth. If heavily soiled, the cloth can be moistened with an approved solvent that does not attack the finish or meter lens, and does not leave a residue. Check switches and pin sockets for tightness.

Internals

Inspect all connections, wiring and components. Check insulation for burning, cracking or other damage. Remove dirt and dust with a soft brush.

Harness

Check interconnect wiring and plug for soundness. Check pins for snug fit in receptacle.

IMPORTANT NOTE

If damage or malfunction is suspected or repairs deemed necessary, consult a Multi-Amp Corporation Representative if it is unclear what course of action should be taken. Please provide Model and serial numbers when making inquiries.

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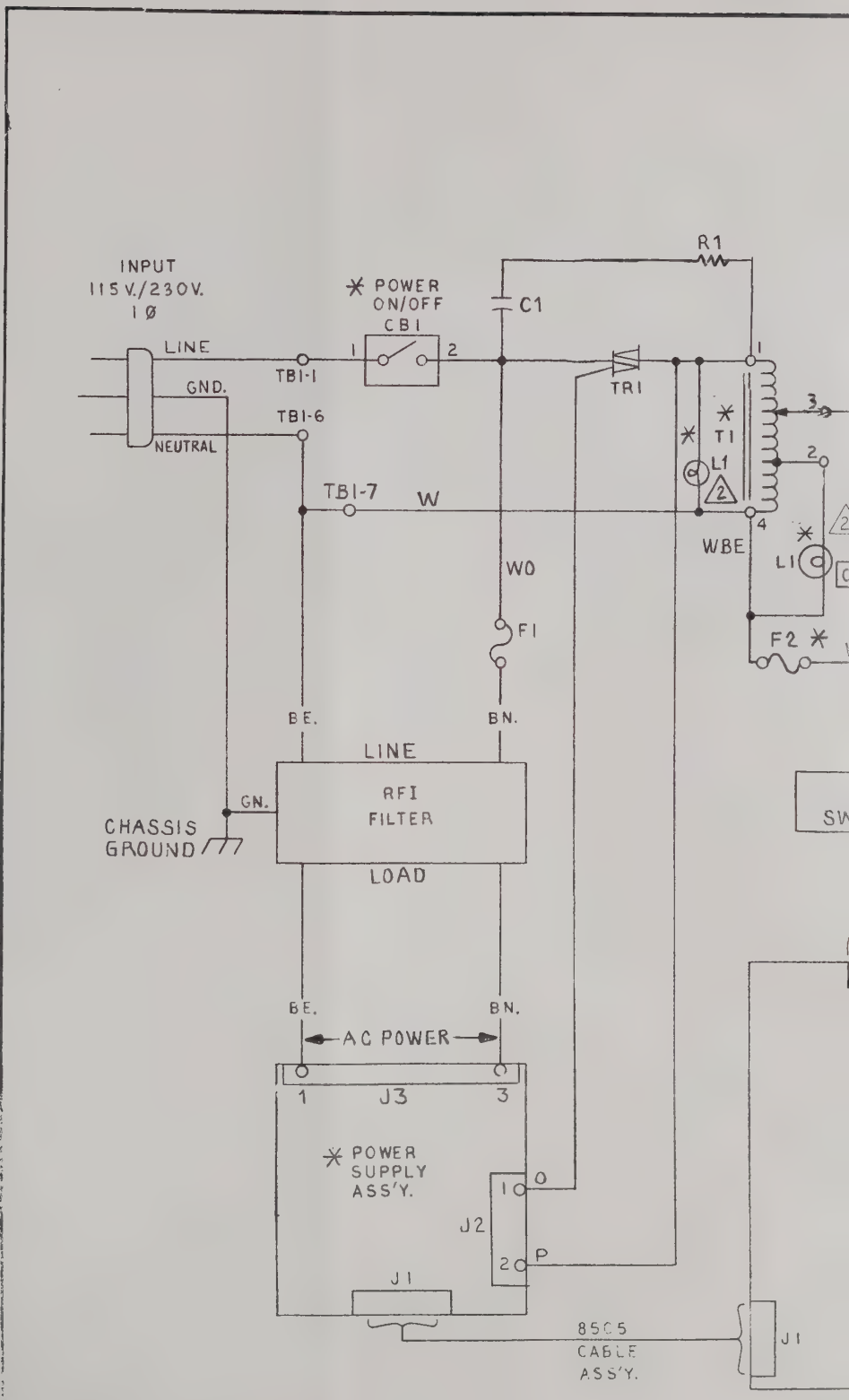
20017C
9639A


INPUT
115 V./230V.
1 Ø
LINE
GND.
NEUTRAL
TB1-1
TB1-6
TB1-7
W
* POWER
ON/OFF
CB1
1
2
C1
R1
TR1
* T1
L1
3
2
4
WBE
L1
WO
F1
F2 *
BE.
BN.
LINE
RFI
FILTER
LOAD
GN.
CHASSIS
GROUND
BE.
BN.
AC POWER
1
J3
3
* POWER
SUPPLY
ASS'Y.
J2
1
O
2
P
J1
8505
CABLE
ASS'Y.
J1
SW

NOTES:

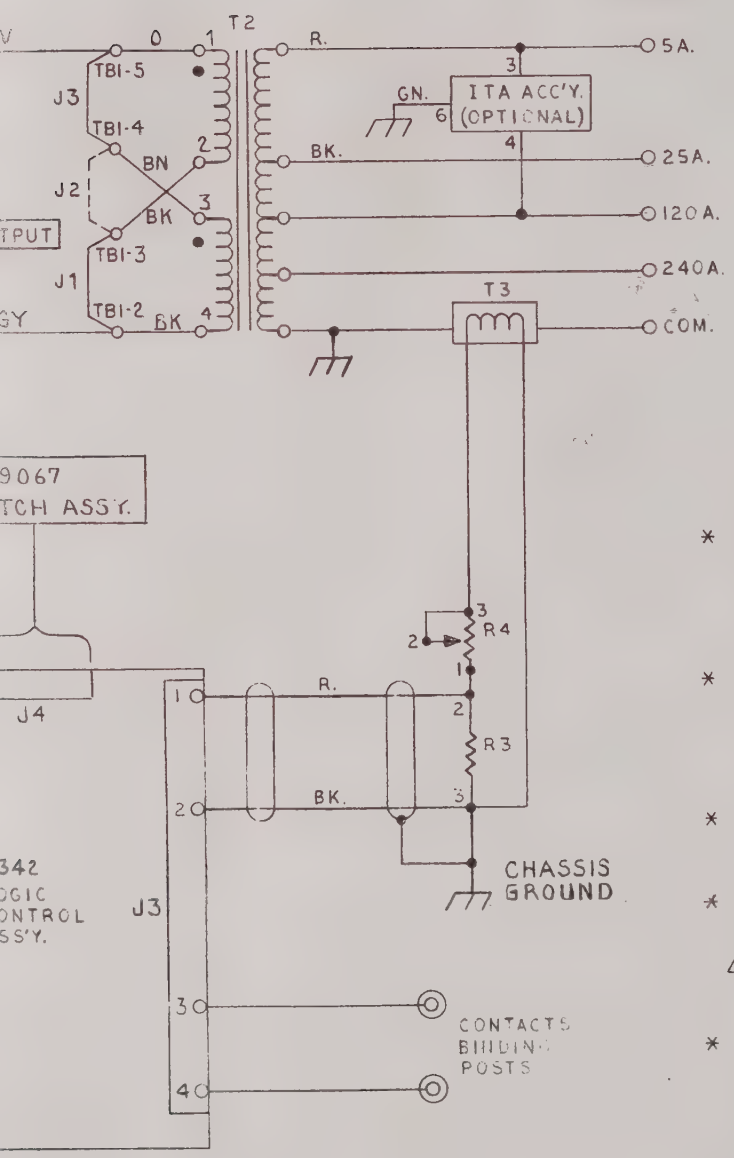
1. (*) DENOTES 230VAC COMPONENTS.

R2 NOT USED

2 ONLY FOR CSA (120V) UNITS, L1 IS LOCATED BETWEEN T1-1 & T1-4. NORMAL CONNECTION T1-2 & T1-4.

RE-DRAWN:

DWG NO 2 017 C		
REV	ECN	DATE
1	15921	8-22-83
2	14082	9-9-83
3	14136	9-19-83
4	14270	10-22-83
5	15204	4-12-84
6	15410	5-16-84
7	22132	7 21 89
8	22459	12 15 89
9	25013	2 2 ..
10	25450	8/10/93
11	25543	9/24/93
12	25576	10-20-93

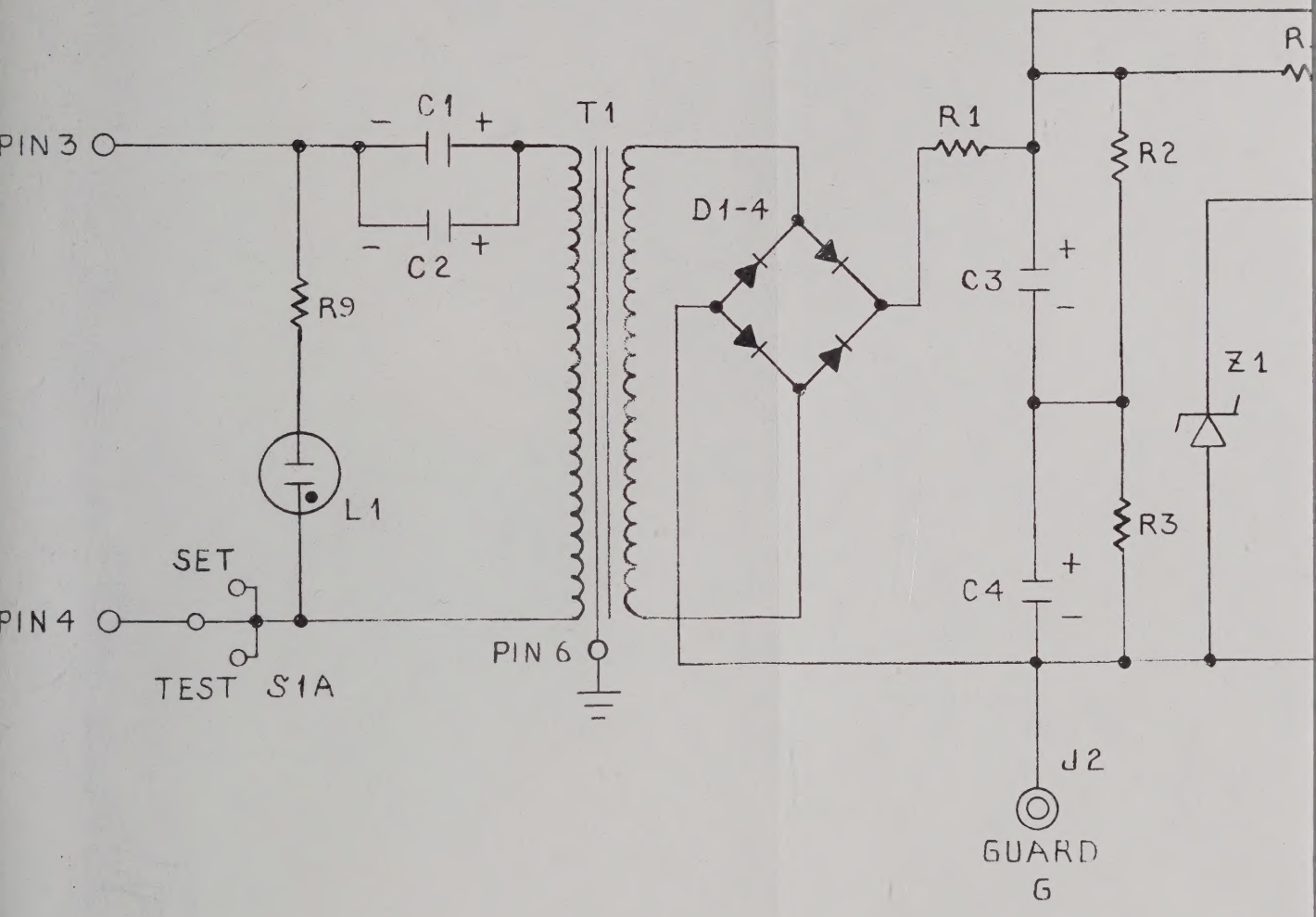


R4	6708	POTENTIOMETER 20[illegible]	1
	8505	CABLE ASS'Y., MS-[illegible]	1
	8616	[illegible]-SUP. ASS'Y. MS-[illegible]	
	8351	PWB, SUP. ASS'Y. MS-[illegible]	1
TR1	43[illegible]	TRIAC 25A. [illegible]	
T3	8545	TRANS. [illegible]	1
[illegible]	9375	TP [illegible] TR	1
T1	3402	TR [illegible]	1
[illegible]	[illegible]	TP [illegible]	1
[illegible]	6311	[illegible]	
R1	1431	[illegible] 8K [illegible] 2W	1
L1	9451	LAMP 48V [illegible]	1
[illegible]	8456	LAMP 24V #334 [illegible]	1
J1-2	8015	[illegible]	3
F2	1128	FUSE 5A. [illegible]	1
F1	984	FUSE 10A. SLO-B[illegible]	1
2 L1	15643	LAMP NEON 120V	1
[illegible]	984	[illegible] 1/2A. [illegible]	
CB1	8172	[illegible]	
CB2	8173	CIR [illegible]	
C1	4304	CAP [illegible] .035MF [illegible]	
REF. DES.	PART NO.	DESCRIPTION	QTY

Multi-Amp
An Indian Head Company
4[illegible] Bronze Way Dallas, Texas 75237 USA
Telephone (214) 333-3201 TWX 910-861-9052

TOLERANCES DECIMAL ±.010 FRACTIONAL ±1/64 UNLESS NOTED	DWN. AEF	[illegible]	SCALE NONE
	CHK D.	DATE 5-7-84	SHT 1 OF
TITLE	SCHEMATIC-MS-2 115/230 VAC		
PART NO MS2	DWG NO 2 017 C		REV 12

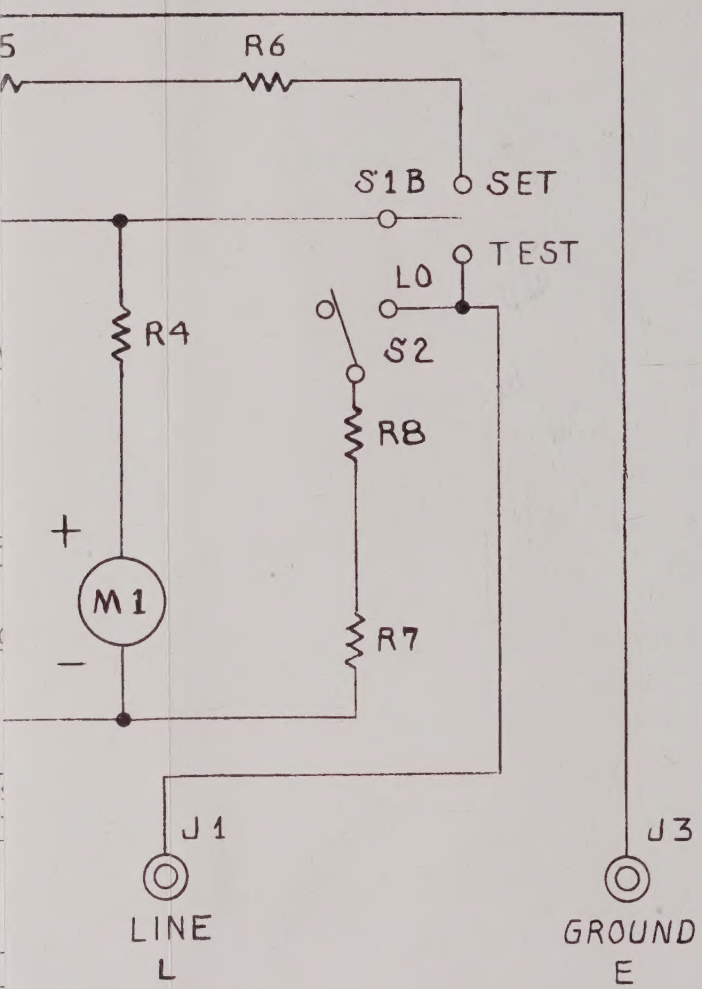
THE DEVICE DEPICTED AND DESCRIBED HEREON EMBODIES PROPRIETARY DESIGN OWNED BY MULTI-AMP CORP. ALL DESIGN, MANUFACTURING, REPRODUCTION, SALES AND PATENT RIGHTS REGARDING THIS DEVICE OR DRAWING ARE RESERVED, EXCEPT WHERE EXPLICIT RIGHT IS GRANTED IN WRITING



Z1	1537	ZENER DIODE	
T1	2340	TRANSFORMER	
S2	767	SWITCH	
S1	768	SWITCH	
R9	1421	RESISTOR	56K 1
R8	2347		750Ω
R7	2345		33.2K
R5,6	2346		10M 1
R4	1316		300K
R2,3	23[illegible]	RESISTOR	47K 1

THE DEVICE DEPICTED AN
PROPRIETARY DESIGN OWN
MANUFACTURING, REPROD
REGARDING THIS DEVICE O
WHERE EXPLICIT RIGHT IS

DWG. NO.	REV NO.	ECN NO.
9639 B	6	4990 9-2-80
	7	10170 9-1-81
	8	16799 2-12-85
	9	19078 4-2-86
	10	21291 1-11-88



ITEM	PART NO.	DESCRIPTION
R1	1433	RESISTOR 1K 10% 1W
M1	2333	METER 0-25MA
L1	2339	PILOT LIGHT
D1-4	2341	DIODE SEL 2.75MA 1KV
C3,4	2343	CAPACITOR 4 MFD 350V.DC ELE.
C1,2	2399	CAPACITOR 1 MFD 400V.DC

) % 1/2 W.
. 1% 1/2 W.
< 1% 1W.
% 1 W.
0.5 % 1/2 W.
% 5 W.

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GRANTED IN WRITING.

multi-amp CORPORATION
4271 BRONZE WAY, DALLAS, TEXAS 75237 (214) 333-3201

TOLERANCES: DECIMAL ±.010 FRACTIONAL ±1/64 UNLESS NOTED	DWN. RMD	APPD.	SCALE NONE
	CHK'D.	DATE 9-3-80	SHT. 1 OF 1

TITLE SCHEMATIC ITA-1

PART NO.	DWG. NO.	REV
	9639 B	10

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